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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Magnitude and frequency of heat and cold waves in recent decades: the case of South America" *by* G. Ceccherini et al.

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1 General comments

The paper examines the highly relevant issue of heat and cold waves, two natural hazards which can significantly impact human and natural systems. It uses a new metric, the Heat Wave Magnitude Index, which is well-received within the international scientific community. An analog metric for cold waves is used for consistency. The methods are outlined clearly and the results support the conclusions reached by the author. Although the study is limited to a certain extent due to its use of point observation data rather than continuous, gridded products, these caveats are discussed in the paper. The results are presented clearly and concisely in the text, but the figures and supple-

ment should be completely reworked before publication.

2 Content issues

In general, the paper's conclusions are limited to the scope of point observations made at stations which are unevenly spatially distributed. This is acknowledged by the authors and for the most part treated sensibly. However, certain statements in the paper are misleading due to the nature of the data analyzed - e.g. on lines 12, 13, pg. 738 in the abstract. Here the authors state that "up to 75% more events [occured] in the last 10 years." Strictly speaking, up to 75% more events were *observed* in the data. Coverage in wide areas, e.g. in Brazil and Argentina, is sparse, and especially dense in other areas, e.g. in Ecuador. As heat/cold waves do not occur homogeneously throughout all of South America, the locations of the observing stations surely leads to a difference between the increase in occurrences in all of South America vs. observations made at these specific stations. I agree with the authors' choice to use the station data, especially since the metrics they use are based on daily minima and maxima, which are more accurately captured in the spatially sparse but temporally high resolution stations than in reanalysis data. However, it is important to acknowledge the limitations of the data.

Also, the supplement is not really helpful - it is composed only of plots which have the same general problems as the plots included in the paper (see the next section for details). It would be very interesting if the actual data - i.e. the occurrences of heat / cold wave events and their magnitude - were included in the supplement, e.g. as CSV. As it is, the supplement could just as well be left off.

Lines 3-6, pg. 7383: I'm not convinced that this paragraph is necessary, and in its present form it is definitely not meaningful. First of all, the proportion of available station data per country is not relevant for the rest of the study. Additionally, comparing

the absolute number of available stations without normalizing for the area of their containing units - countries - is misleading. It should be clear that Brazil has many more stations than French Guyana, since it's so much larger.

Line 10-11, pg. 7385: The authors state that "... The intermittent nature of heat ... waves prevents from carrying out trend analysis..." Without having seen the data, I would assume that a Poisson regression would be well-suited to analyzing its trends. If this type of regression is unsuitable, there are surely other types of trend analysis that can be used on sparse observations that occur with low frequency. The trends such an analysis would project would be much more interesting for the paper; heat and cold events are simply not expressed in the yearly averages and the strength of this paper is that it examines these events using a robust, generalized metric suitable that captures these events well.

Lines 1-3, pg. 7387: This is a good observation, but the authors are comparing a period of 9 years with a period of 24 years. It makes the conclusion they draw from it all the more interesting, but it should either be normed (e.g., "between 2005 and 2014 the frequency of extreme heat waves had increased to 40 observations per year, as compared to 8.5 per year in the period from 1980 to 2004") or accentuated in the text.

I find the figures problematic (more about that in the following section), but the information they contain is very interesting. It would be nice if the hot spots of increases in HMWI frequency and magnitude would be discussed in the text. As it is, this gem disappears unless the reader discovers it on his own.

Lines 9-16, pg. 7387: Here the authors describe an example year. Is this year significant for some reason, or was it chosen at random? Both would be fine, but it should be stated in the paper.

Section 3.4., specifically pg. 7390: I'm not convinced that the indicators used are suited. First of all, the second indicator is Mean Absolute Error, not Absolute Error (AE would be for a single observation). Secondly, both RMSE and MAE are used

for measuring errors, e.g. in predictive models, and this is not the case here. The authors are examining deviance of a subpopulation from its superpopulation. In this case, deviance indicators, not error indicators, should be used.

3 Technical issues

Lines 16-18, pg. 7380: This sentence can be inferred from the previous ones. I suggest leaving it out.

The English in the paper is good, but the study would benefit nonetheless from proofreading.

Line 14, pg. 7381: I would write "sensing network" rather than "gauge network".

Line 16, pg. 7382: It would be nice if section 2.2. were referenced here so that the reader knows where to look to find criteria for selecting stations.

3.1 Figures

In my opinion, the figures should all be completely reworked.

First of all, figures should be interpretable without having to know where they are described in the text. The text can, of course, refer to them and provide context, but units, variables, etc. should be in captions next to the figures rather than in the text. Too often relevant information is written in the text and not in the caption, which both makes the figures difficult to interpret and interrupts the flow of the text (e.g. lines 15-18, pg. 7386; lines 16-17, pg. 7388; lines 12-15, pg. 7389; other paragraphs might be affected as well). Also, in many cases the figures are scaled so that the reader is required to analyze and interpret a lot in order to understand it in a way that is not misleading. Readers shouldn't have to do math in their head - figures should display the data in a

way that the data can be interpreted as intuitively as possible.

Concerning the maps - South America is such a big area that the latitude/longitude axes are not necessary. Especially in the small maps they're distracting.

Figure 2: The axis labels are too small. Also, the combination of bargraphs and maps reduces readability. Consider breaking this up into two plots. Also, the magnitude classes are a bit confusing - does 16-32 occur at all? If it does not (I was unable to find an occurrence) it should be removed from the legend. The increase in heat wave frequency could be better demonstrated by using the same scale in all bargraphs - otherwise the reader sees only that frequency decays with intensity if he does not mentally scale the bars. The same applies to figure 5.

Figure 3: The authors use a logarithmic y-axis. It would be helpful to state that on the scale. Also, the legend is interpretable, but it's clearly from the plotting program and written differently than if it were being prepared for readers. I would suggest completely redoing this figure. First of all, the variable names need to be in the caption. The plot could also be interpreted more intuitively if different colors were reserved for magnitues and time were plotted on the x-axis, rather than magnitude on the x-axis and colors signifying time periods. The authors might also consider adding trend lines. The same applies to figure 6.

Figure 4: This plot shows an interesting spatial distribution. It would be nice if this were discussed in the text. Also, as in figure 2, the class 16-32 does not occur!

Figure 7: Please use uniform descriptions in the caption for the panels within the plot, e.g. "...mean annual maximum temperature (TX, left panel)...". I would suggest using uniform maxima / minima for all 3 subplots. However, MTR should use a different color scale. It's not describing an increase or decrease of temperature, but an increase in the the spread between minimum and maximum. A grayscale or some other scale that indicates intensity would be better suited, otherwise readers might interpret a bright red value of 1.0 to mean that warmer temperatures were observed, whereas this value

could theoretically occur at a station where the minimum gets colder faster than the maximum temperature, even though both means decrease over time.

Figure 8: The axes are too small to be readable with many printers, please enlarge them. It looks like the authors are using R - in this case the plot could be painted in a smaller viewport and the font size would be larger in proportion to the rest of the plot automatically.. The values are very jittery, and this makes interpretation of the figure unnecessarily difficult - the long-year average temperature on a specific day in the year is not meaningful. I would smooth the values using e.g. a moving window of 5-10 days. This would also remove the outliers, which don't provide meaningful information, and simultaneously reduce the range on the y-axis, which would increase the information density shown. The same applies to figure 9.